Design Space Exploration/Identification In Elegant System Design and Operation

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Principles of Elegance

- Elegant Systems are
  - Effective
  - Efficient
  - Robust
- Elegant Systems Manage and Minimize
  - Unintended Consequences

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System Engineering Framework

- Elegant Systems are achieved through
  - Understanding the Mission Context
  - Managing the Physical and Logical System Interactions among the system components and with the system environment
    - Physics (Structural, Thermal, Fluid, Electrical)
    - Logical (Data and Information)
  - Managing the Organizational Structure and Information Flow
  - Understanding the Policy and Law Constraints
    - Federal Aviation Administration (FAA) Regulations

Properties of Elegance

- Simplicity in Function and Operations
- Espalier: Seamless integration of secondary functions
- Efficient Configuration within the Mission Context
- Robust in Operation and Application
  - Evolve in a graceful manner
- Minimize Unintended Consequences

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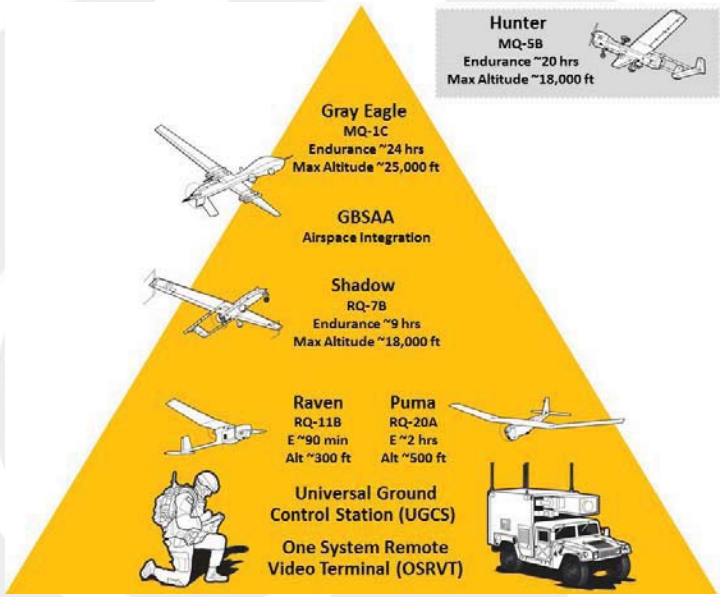
Design Space Exploration/Identification

- Design Space Exploration/Identification is:
  - Defined by the Mission Context
  - Defined by the System Physics
  - Constrained by schedule, budget, policy, and law
  - Influenced by organizational dynamics
- Focus is on finding the most efficient system configuration

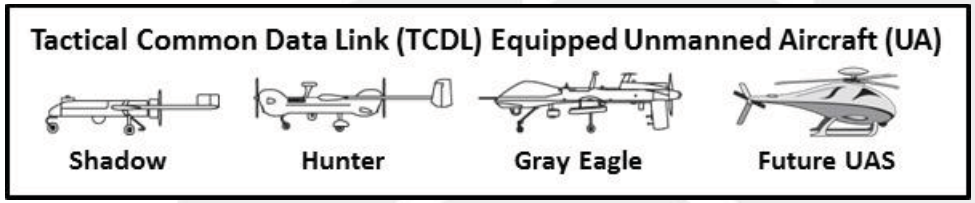
Design Space Exploration/Identification

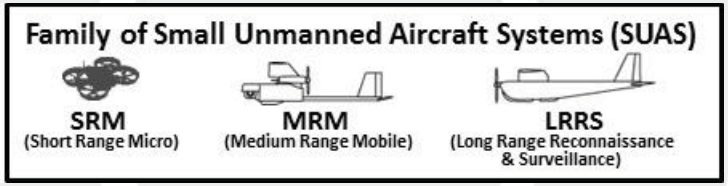
- Mission Context
  - How is the system to be used?
    - Loiter time
  - What are the operational constraints?
    - Deployment location
  - What is the operational environment?
    - Dedicated operator or field soldier
    - Remote operations center or field operated
  - What is the maintenance philosophy?
    - Single flight
    - Field maintenance, depot maintenance
  - What is the post mission assessment approach?
    - Local field assessment, strategic assessment



Design Space Exploration/Identification

- System Physics
  - Aerodynamics
  - Propulsion System
  - Launch System
  - Recovery Systems





- System Efficiency defined by System Physics
  - System Exergy provides a complete thermodynamic efficiency of the integrated system to examine all possible system configuration options

  - Provides an integrated analysis of all system interactions within the system and with the environment
  - Has been shown to identify discontinuous design solution spaces with improved system characteristics

Design Space Exploration/Identification

- Design Space is constrained by Budget, Schedule, Policy, and Law
  - Budget limits configuration options
    - Development
    - Production and Operations (includes sustainment)
  - Schedule limits configuration options
    - Development
      - » How soon does the system need to be to market or fielded?
    - Production and Operations
      - » Production pipeline
      - » Operations support
        - Team size
      - » Maintenance Approach
        - Field maintenance or depot maintenance

Design Space Exploration/Identification

- Design Space is constrained by Budget, Schedule, Policy, and Law
  - Organizational Dynamics
    - Defines the efficiency with which a specific organizational structure can achieve a specific configuration
  - Policy and Law constrains configuration options
    - Federal Aviation Administration (FAA) Regulations

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Design Space Exploration/Identification

- Be Aware of Unintended Consequences

  - Error (Mistakes)
  - Ignorance (Not Knowing or Not Understanding)
  - Bias
    - Cultural
    - Historical

  - Short Sightedness (Imperial Immediacy of Interest)
  - Self Defeating Prophecy
- Early design space exploration needs to have assumptions well grounded

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Summary

- System Elegance starts in Design Space Exploration/Identification
  - Design Space Exploration/Identification is defined by Mission Context and System Physics
    - Identify the most efficient configuration for the system
    - System exergy analysis potentially allows broader design space exploration
  - Design Space is constrained by Budget, Schedule, Policy, and Law
    - Sets the local conditions within which to find the most efficient option
  - Design Space is influenced by the organizational dynamics
    - Sets the efficiency with which the organization may achieve the most efficient option

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